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Dendrolobium arbuscula (Domin) H.Ohashi, *D. umbellatum* (L.) Benth. and a Related New Species (Leguminosae-Papilionoideae: Desmodieae)

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Distinction of *Dendrolobium arbuscula* (Domin) H.Ohashi from *D. umbellatum* (L.) Benth. is confirmed by flower and pollen morphology. A new species, *D. papuacola* H.Ohashi & T.Nemoto, is described from Papua New Guinea which is closely allied to the former two species. A key to these species is provided. A revised description of *D. arbuscula* is presented. Pollen morphology of these three species are described.

Key words: *Dendrolobium*, *Dendrolobium umbellatum*, Desmodieae, Leguminosae, pollen morphology

Desmodium arbuscula Domin was described in 1926 from North Queensland, Australia. It was distinguished from *Desmodium umbellatum* (L.) DC. in having leaves glabrous on the lower surface, flowers larger and with the wings larger than the keels, and glabrescent few-jointed pods. However, this species had not been recognized as distinct, probably because of its similar feature to the latter in umbellate short inflorescences, white flowers, and obovate leaflets. Ohashi (1997) transferred this species to *Dendrolobium* as *Dendrolobium arbuscula* (Domin) H.Ohashi, and recorded it newly from New Guinea based on specimens identified by van Meeuwen (1962) as *Desmodium quinquepetalum* (Blanco) Merrill and, also, from Fiji. There remain, however, several problems in *Dendrolobium arbuscula*. First, the differences between *Dendrolobium arbuscula* and *D. umbellatum* found by Domin (1926) need to be reexamined based on ample material, because clear discrepancies are noted in features of leaves, calyx, petals, and pods between the specimens examined and the original description. Second, pollen morphology of *D. arbuscula* needs to be recorded, because *Dendrolobium* is distinct from *Desmodium* in pollen morphology, i.e., coarsely reticulate in the former vs. finely reticulate or rarely coarsely reticulate in the latter (Ohashi 1973).

During this study, moreover, a collection from Papua New Guinea, i.e., Loloki River, Brass 1654 (A, K), has been noted by distinct characteristic features of its leaflets and flowers. Although based only on one collection, we recognized it as a new species near to *D. arbuscula* and *D. umbellatum.*

In this paper, distinctions among *Dendrolobium arbuscula*, *D. umbellatum* and *D. papuacola* are clarified; description of *D. arbuscula* is revised; and pollen grains of these three species are described in which those of *D. arbuscula* and *D. papuacola* are recorded for the first time.

Key to the species

1. Lowest calyx-lobe longer than other lobes.

Wings longer than keel. Terminal leaflet usually smaller than 6×2.5 cm. Leaves uniformly but inconspicuously puberulent or pubescent beneath 2

2. Terminal leaflet narrowly ovate to narrowly elliptic. Calyx 3.5–4 mm long, the upper lobe distinctly 2-toothed, lateral lobe shorter than the tube; pedicels 2.5–3 mm long in flower... 1. *D. papuacola*
2. Terminal leaflet obovate to elliptic. Calyx about 6 mm long, the upper lobe slightly 2-toothed, lateral lobe as long as the tube; pedicels 3–6 mm long in flower. Pods (1–)3–4-jointed, with persistent

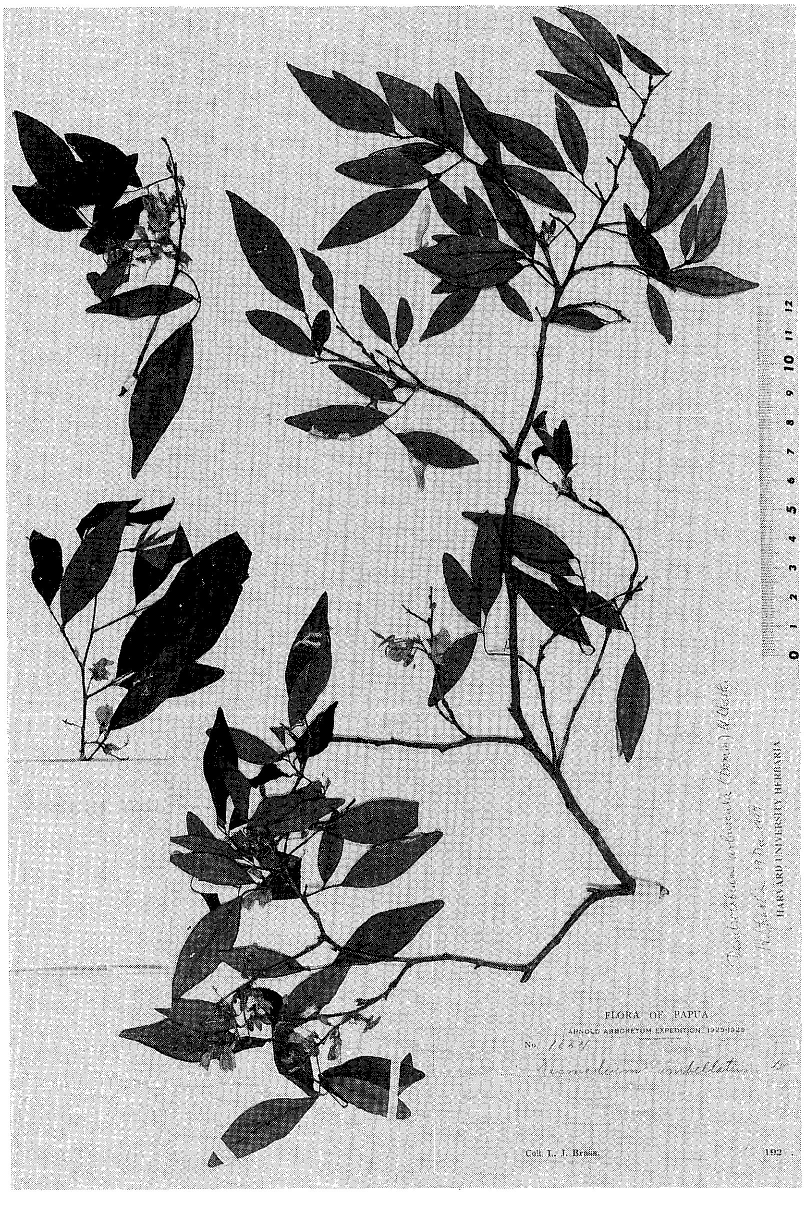

Fig. 1. Holotype of *Dendrolobium papuacola* H.Ohashi & T.Nemoto. Brass 1654 (A).

calyx at base .... 2. *D. arbuscula*

1. Lowest calyx-lobe as long as other lobes. Wings as long as but distinctly smaller than the keel. Terminal leaflet longer than 5 cm. Leaves densely appressed pubescent or sericeous beneath. Calyx 4–5 mm long, the lateral lobes longer than the tube and as long as the lowest one. Pods 3–8-jointed, with persistent calyx at base .... 3. *D. umbellatum*

1. **Dendrolobium papuacola** H.Ohashi & T.Nemoto, sp. nov. (Figs. 1–3)

A *Dendrolobio umbellato* et *D. arbusculo* foliolo terminali anguste ovato vel anguste elliptico et calyce minus quam 4 mm longo differt; a priore alis carina longioribus et calycis lobo abaxiali lobis lateralibus longioribus differt; a posteriore calycis lobis lateralibus tubo brevioribus et pedicello breviore differt.

Type. Papua New Guinea. Loloki River. Brass 1654 (Holotype in A, photo in TUS; Isotype in K).

Small tree, branches gray, glabrous, branchlets of the year uniformly appressed pubescent. Leaves 3-foliolate; stipules deciduous, dark brown, striate, glabrous outside, densely ciliate, ca. 5 mm long; petioles 0.5–1.5 cm long, longer than rachis; rachis 4–10 mm long; stipels persistent, filiform, ca. 2 mm long. Leaflets coriaceous, appressed short pubescent on both surfaces when young but later glabrescent above; terminal leaflet narrowly ovate to narrowly elliptic, 3.5–6 cm long, 1–1.8 cm wide, acuminate but obtuse at tip, cuneate to base; lateral nerves 6–7, inconspicuous, looped within but very close to the margin; lateral leaflets smaller than the terminal one, not or slightly oblique at base.

Inflorescences reduced racemose or umbellate, axillary, umbels with 3–5 flowers; rachis or peduncles 0.5–1 cm long, densely appressed white pubescent. Pedicels 2.5–3 mm long, densely appressed puberulent; bracteoles narrowly ovate to elliptic, 1–2 mm long, acuminate to obtuse, pubescent, densely ciliate. Calyx 4-lobed, 3.5–4 mm long, pubescent outside and inside of lobes; tube ca. 2–2.5 mm long, upper lobe broadly ovate, 1–1.5 mm long, 2-toothed at apex, lateral lobes narrowly triangular, 1–1.5 mm long, lowest lobe longest, ca. 2 mm long, triangular, acute. Corolla white, membranous, glabrous; standard broadly obovate, emarginate at apex, 10.5–11 mm long, lamina ca. 9 mm long, ca. 8.5 mm wide, gradually narrowed to claw, the claw ca. 2 mm long, with a pair of small green basal patches on the lamina; wings longer than the keel, narrowly elliptic, ca. 12 mm long, lamina 9.5–10 mm long, 3.5–4 mm wide, obtuse at apex, with sculpture on basal part, small auriculate, claw 2–2.5 mm long; keel ca. 11 mm long, slightly incurved, lamina 8–8.5 mm long, 3–3.5 mm wide, obtuse at apex, adnate to the wing, auriculate at base, claw ca. 3 mm long. Stamens monadelphous, 10–11 mm long, curved upwards in distal part, anthers uniform, narrowly ovate; disk absent; pistil densely appressed pubescent, gradually narrowed to the style.

Pollen grains (Fig. 3) tricolporate; (21–) 22(–25) μm in polar axis, (15–)17(–18) μm in equatorial diameter; P/E=(1.20–)1.36(–1.49), subprolate to prolate in shape, elliptic or rectangular-elliptic in equatorial view, semiangular in polar view; colpi long, 0.7–0.8 the length of the polar axis, very narrow ca. 1 μm wide at equator, narrowing to pointed ends, colpus membrane with fine granules, margins with a complete tectum; endoaperture 0.2–0.3 the length of polar axis; semitectate; sculpture in mesocolpium reticulate, lumina 1–1.5 μm in diameter, with columellae elements.

The new species differs from *Dendrolobium umbellatum* and *D. arbuscula* in having narrowly elliptic leaflets, smaller calyx less than 4 mm long; from the former in having wings longer than the keel, and the lowest calyx-

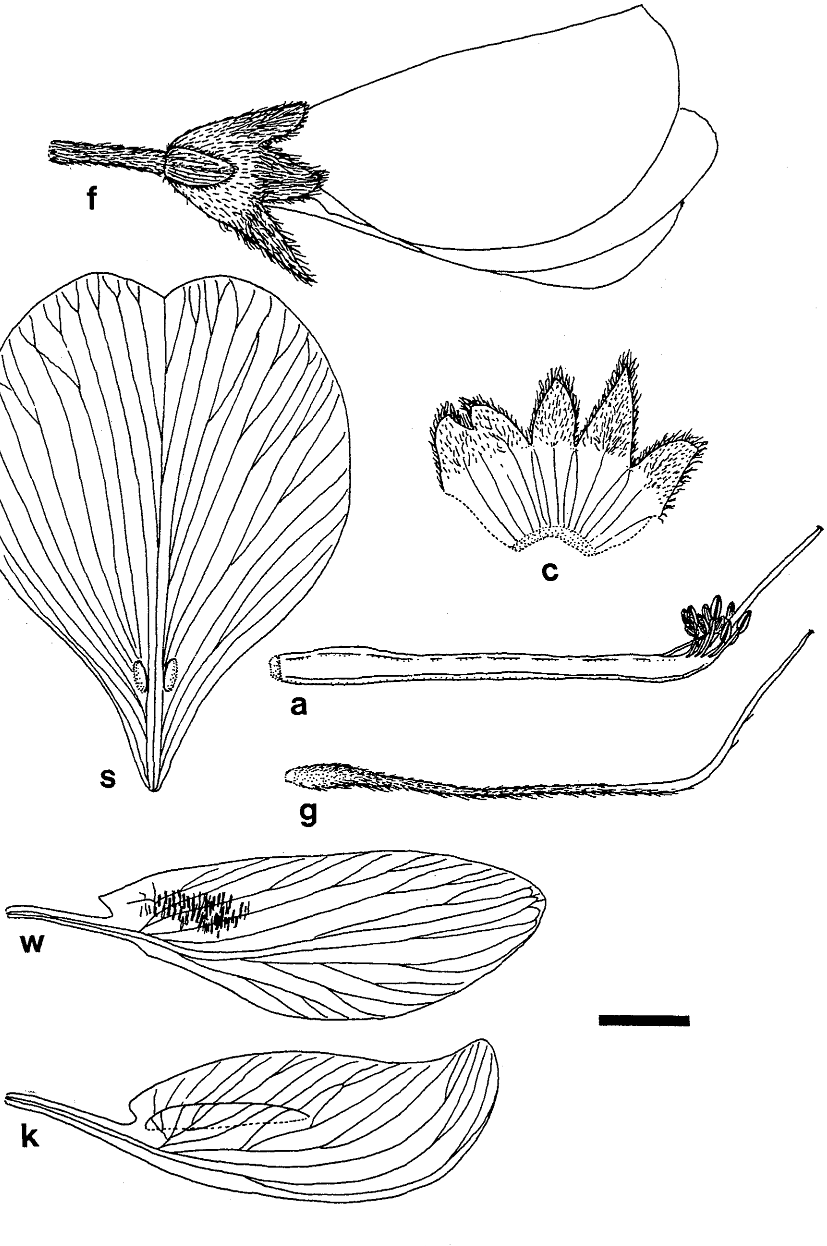

Fig. 2. Flower of *Dendrolobium papuacola* H.Ohashi & T.Nemoto. f, flower (cf. Calyx-lobes reflexed in anthesis). s, standard. w, wing. k, keel. c, calyx dissected (inside). a, stamens with a part of pistil. g, pistil. Scale bar = 2 mm long. Voucher specimen: Brass 1654 (A).

lobe longer than the other lobes; and from the latter in having shorter pedicels and the calyx with distinctly toothed upper lobe and with lateral lobes shorter than the tube.

Pollen morphology of *Dendrolobium papuacola* differs from that of *D. umbellatum* in the size of lumina, but similar to *D. arbuscula.*

2. **Dendrolobium arbuscula** (Domin) H.Ohashi in Taiwania **42**: 137 (1997) (Figs. 4–6).

Desmodium arbuscula Domin in Biblioth.

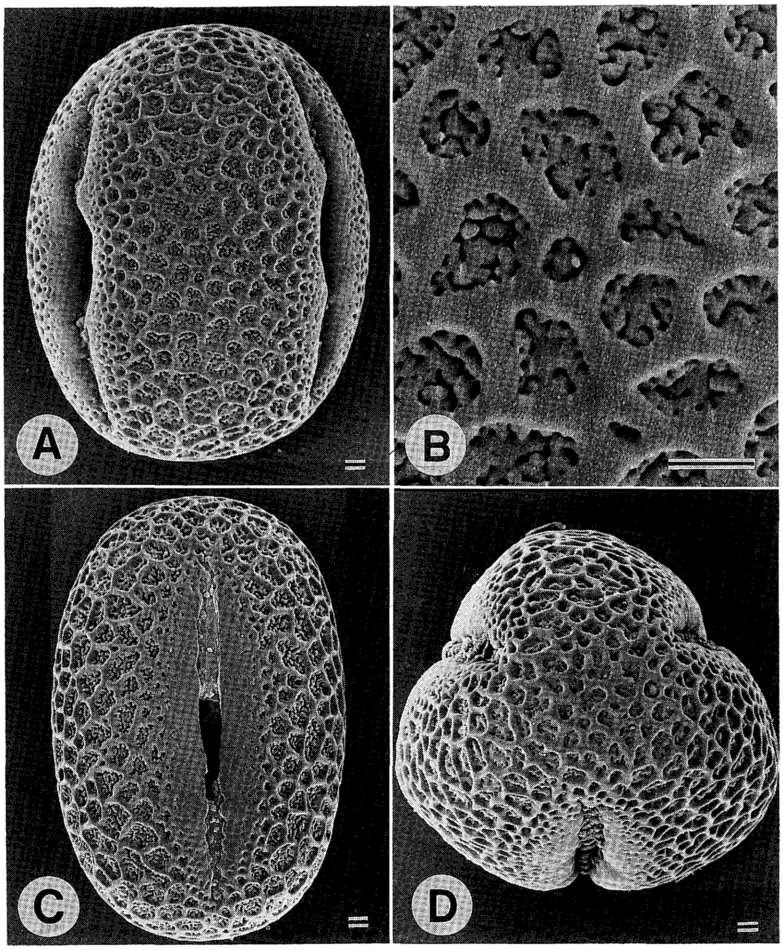

Fig. 3. Pollen grains of *Dendrolobium papuacola*. A. Equatorial view showing mesocolpium. B. Mesocolpium, enlarged. C. Equatorial view showing a colpus. D. Polar view. Scale bar = 1 μm. Voucher specimen: Brass 1654 (A).

Bot. **89**: 211 (1926). [Type: Nord-Queensland: in der Umgebung von Chillagoe als kleiner Baum oder grosser Strauch, ser häufig in den Savannenwäldern, aber stellenweise auch auf den Felsen; ebenso bei Mungana. K.Domin, Feb. 1910. (PR not examined)].

Tree to 10 m tall; barks thick corkly, deeply tesselated; young branches pubescent. Leaves 3-foliolate; stipules early deciduous, striate, glabrous outside, densely ciliate, 4–5 mm long, obtuse and shortly apiculate at apex; petioles 1–3 cm long, appressed to spreading pubescent; stipels persistent, subulate, 3–5 mm long; leaflets chartaceous to subcoriaceous, glabrous above, sparsely to densely appressed puberulent or pubescent especially on nerves beneath, sometimes almost glabrescent; lateral nerves rather inconspicuous, 6–10 on each side of the midrib, looped within the margin, reticulate nerves inconspicuous; the terminal one obovate to elliptic or narrowly elliptic, obtuse or sometimes acute or rounded at apex, 4–6(–8) cm long, 1–3.5(–4) cm wide, rachis of terminal leaflet shorter than the petiole, 4–15 mm long.

Inflorescences axillary, shortened racemose,

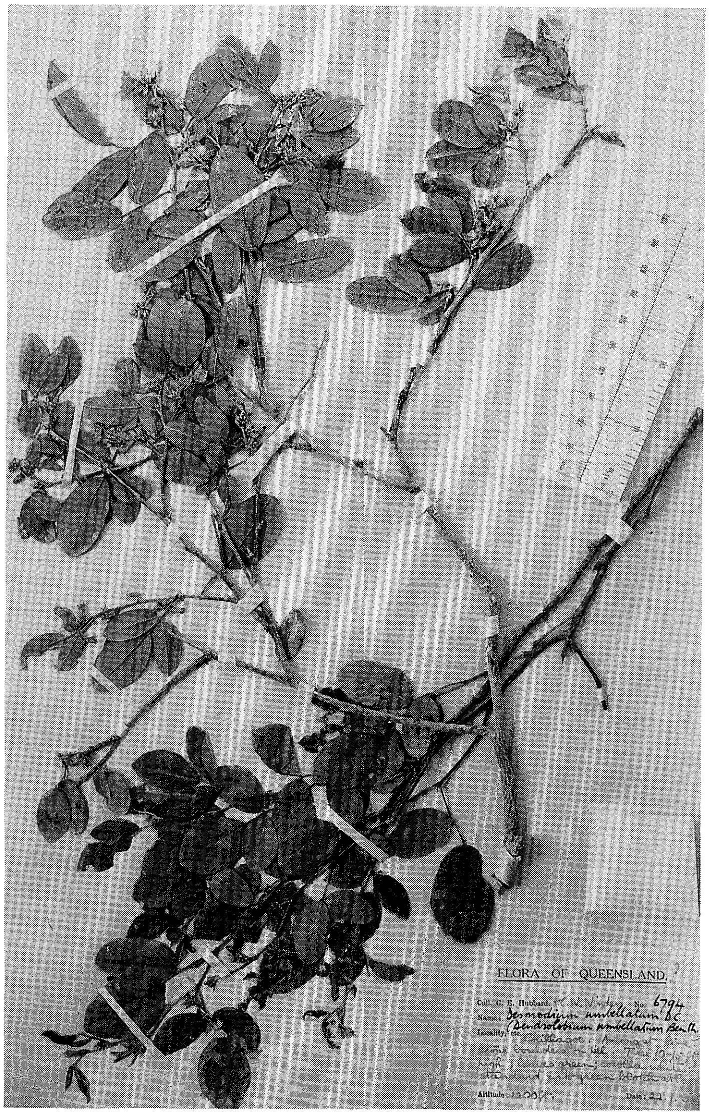

Fig. 4. *Dendrolobium arbuscula* (Domin) H.Ohashi from Queensland. Hubbard & Winders 6794 (K).

5–10(–12)-flowered; peduncles 5–10 mm long, appressed to spreading pubescent; bracts ovate, cymbiform, about 1.5 mm long, pubescent outside, glabrous inside, early deciduous; pedicels 3–6 mm long in flower and 3–10 mm long in fruit; densely appressed puberulent; bracteoles broadly ovate to orbicular, ca. 1 mm long, acute, pubescent, densely ciliate. Calyx 4-lobed, 6–6.5 mm long, pubescent outside and inside of lobes; tube about 3 mm long, upper lobe triangular, 2.5–3 mm long, minutely 2-toothed at apex, lateral lobes narrowly triangular, 2.5–3 mm long, lowest lobe longest, narrowly triangular, acuminate, about 4 mm long. Corolla white, membranous, glabrous; standard nearly orbicular, emarginate at apex, ca. 14 mm long, lamina 11–11.5 mm long, ca. 10 mm wide, gradually narrowed to claw, the claw ca. 2 mm long, with a pair of small green basal patches on the lamina; wings longer than the keel, narrowly obovate, 15–16 mm long, lamina 12–12.5 mm long, ca. 3 mm long; keel 13–13.5 mm long, slightly incurved, lamina 9–9.5 mm long, 3–3.5 mm wide, obtuse at apex, adnate to the wing, gradually narrowed to claw, claw ca. 4 mm long. Stamens monadelphous, alternately longer and shorter, 12.5–13 mm long, curved upwards in distal part, anthers uniform, narrowly ovate, ca. 1 mm long; disk absent; pistil densely appressed pubescent, gradually narrowed to the style, style glabrous in upper part.

Pods narrowly oblong, (2–)3–4-jointed, 1–2.5 cm long, densely or rather sparsely

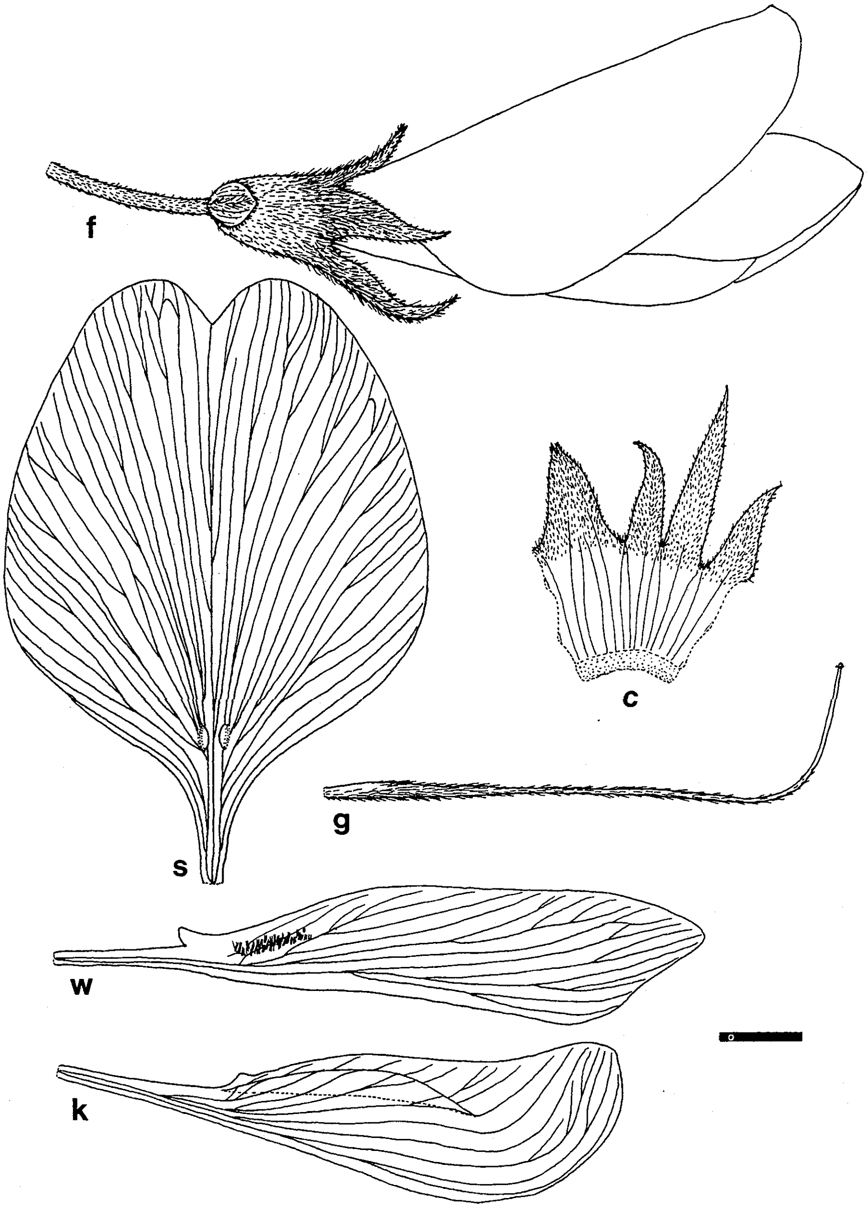

Fig. 5. Flower of *Dendrolobium arbuscula* (Domin) H.Ohashi. f, flower (cf. Calyx-lobes reflexed in anthesis). s, standard. w, wing. k, keel. c, calyx dissected (inside). g, pistil. Scale bar = 2 mm long. Voucher specimen: Brass 8789 (A).

appressed pubescent and sometimes glabrescent, pericarp thick corky in mature, constricted along abaxial suture; articles broadly oblong to nearly orbicular, 5–5.5(–7) mm long, 4–5 mm wide.

Pollen grains (Fig. 6) tricolporate; (21–) 25(–27) μm in polar axis, (16–)19(–20) μm in equatorial diameter; P/E = (1.21–)1.34(–1.50), subprolate to prolate in shape, elliptic or rectangular-elliptic in equatorial view, semi-angular in polar view; colpi long, 0.8–0.9 the length of the polar axis, very narrow, ca. 1 μm wide at equator, narrowing to pointed ends, colpus membrane with fine granules, margins with a complete tectum; endoaperture 0.2–0.3 the length of polar axis; semitectate; sculpture in mesocolpium reticulate, lumina 0.8–1.5 μm in diameter, with columellae elements.

Dendrolobium arbuscula grows in open *Eucalyptus* woodland on sandy soil, red clay loam in Australia. It is remarkably different

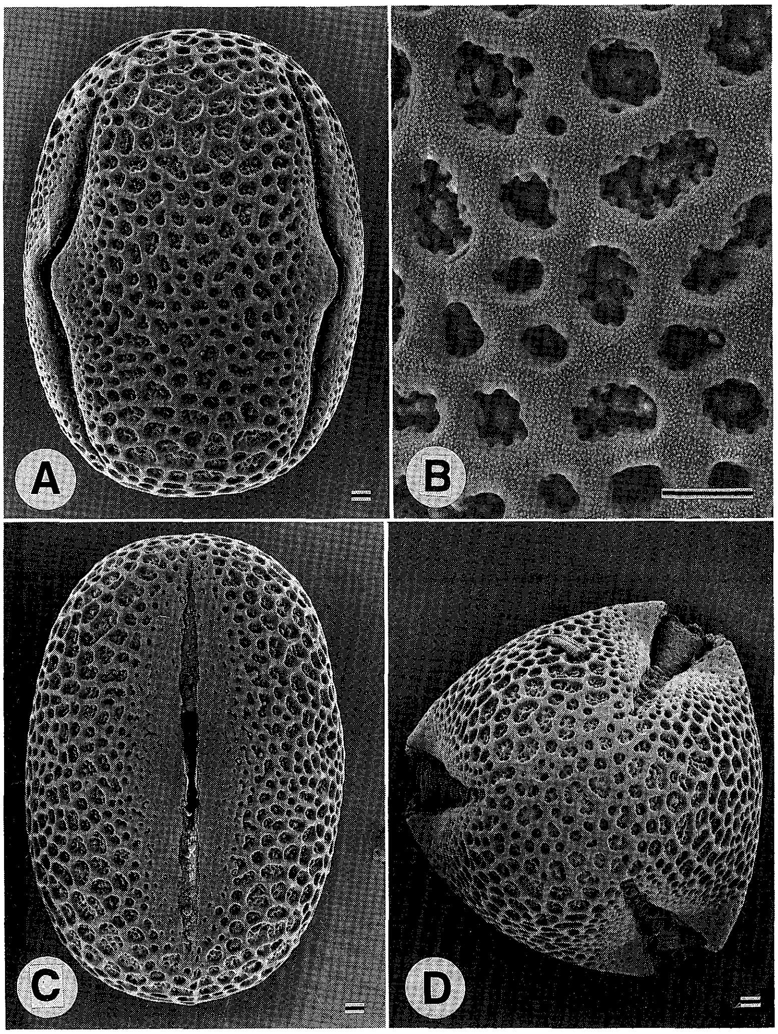

Fig. 6. Pollen grains of *Dendrolobium arbuscula*. A. Equatorial view showing mesocolpium. B. Mesocolpium, enlarged. C. Equatorial view showing a colpus. D. Polar view. Scale bar = 1 μm. Voucher specimen: Brass 8789 (A).

in habitat from *Dendrolobium umbellatum* which grows seaside. *Dendrolobium arbuscula* is similar to *D. quinquepetalum* in having keel-petals smaller than the wings. The plants from New Guinea and Australia were treated by van Meeuwen (1962) as *D. quinquepetalum* on the basis of this characteristic, but both species are distinct (Ohashi 1997).

Pollen grains of *Dendrolobium arbuscula* (Fig. 6) are much similar to those of *D. umbellatum* in the coarse reticulate sculpture, subprolate or prolate shape, long and narrow colpi with distinct the margin, but they differ in lumina size, i.e., *D. umbellatum* (Fig. 5) have generally coarser reticulate lumina than *D. arbuscula.*

Several specimens in NSW which I examined in 1998 are determined by Mr. Pedley as *Dendrolobium arbuscula* in 1992, although his combination was unfortunately not published before my combination in 1997.

Specimens examined:

Papua New Guinea. Rouna Road, near Port Moresby. 19 Aug. 1951. Barrett NGF. 4228 (A, L); Budatobara, 300 ft. Brass 763 (A); Port Moresby, dry coastal area, abundant in monsoon-forest, spreading to savannah-forests. Brass 8789 (A-voucher specimen for flower and pollen morphology, K, L); Port Moresby, sea shore; fls white, c. 8 ft. tall. Carr 11845 (K, L); Central north coast of Yule Island. On rocky cliffs above sea, alt. ca. 30 ft. Shrub c. 5 ft tall, fls. white, leaves bright green above, paler green below. Darbyshire 745 (A); Central Prov. Motupore, Bootless Inlet. alt. 1 m, edge of grassy slope near small house. 31 Mar. 1979. Frodin 5203 (L); Tavai creek, alt. 50 ft. Open eucalypt forest, behind Mangrove littoral. Gillison 22111 (A); Moitaka, alt. 100 ft. Open savannah. Tree, 15 ft. Gillison 22131 (A, L); Fairfax harbour. Gillison 22165 (A); Tovobada Hills, N.N.W. of Port Moresby, alt. c. 600 ft. Common tree in local monsoon scrubs and low forests on stony hill topography. This tree 42 feet tall. Flowers white, wings and keel of equal length. Pullen 6992 (A); Mori River, c. 15 km NE of Cape Rodney. Rain-forest on riverine alluvium, alt. 15–30 m. Tree c. 7.6 m tall on riverbank in forest. Foliage apparently semideciduous. At time of collection this tree had mainly newly-developing foliage while bearing white flowers. Standard with a small green basal patch, other perianth segments all white. Pullen 8132 (A, TNS); c. 1 mile south-east of Kapa kapa. Shrub c. 2.5 m high. Schodde 2781 (A); North vicinity of Rigo. Schodde 2699 (A); 3 mile hill, Port Moresby, alt. 100 ft. Low scrub at roadside. Womersley NGF. 16681 (L).

Australia. Queensland. Thursday Island. Bailey s. n. (NWS); Cook, Bick in 1914 (NSW); Cape York Peninsula, Archer River. Frequent on alluvial banks of anabranches of the river. Alt. 125 m. Tree or shrub 3–5 m tall, leaves grayish below. Brass 19755, July 31 1948 (A, K, L); Queensland. Cape York Peninsula. Archer River, Wenlock-Coen Road. Frequent on alluvial banks of anabranches of the river. Alt. 125 m. Tree or shrub 3–5 m. tall, leaves grayish below. 31 July 1948. Brass 19755 (TNS); Cook, Alma-den. Cambage 3858 (MSW); 45 km from the Waksg River crossing on the Mungana to Wrotham Park Road. Clarkson 2802 (NSW); 8 km south of Wakooka on the track to Starke Station. Clarkson 7306 (NSW); 6 km south of Coen on old road to Musgrave, 1 km north of the first crossing of the Stewart River. Clarkson 7707 & Neldner (L); Entrance to “Royal Arch Cave”, c. 8 km south west (by road), from Chillagoe. Conn & De Campo 1358 (NSW); Boggy Creek. Craven 3229 (L); Chillagoe, amongst limestone boulders on hill, alt. 1200 ft. Hubbard & Winders 6794 (K, L); Bathurst Heads. Hyland 4852 (L); Few miles North of the Morehead River on Coen Road. Hyland 5299 (L); Four Mile Creek – Almaden. Hyland 5818 (L); Lankelly Creek Road, alt. 450 m. Hyland 8717 (L); Chillagoe, amongst limestone boulders on hill; tree 10–15 ft. high, elaves green, corolla white, standard with green blotch at base, alt. 1200 ft. Hubbard & Winders 6794 (K, L); Kalpowar, W side of Bathurst Range, mixed semideciduous forest at foot of slope. Kanis 1989 (L); Queensland, Cook District, Bolwarra road about 15 miles from Chillagoe. Macdonald 3 (NSW); Chillagoe, open limestone country. N. Michael 269 (BM); Walsh River. Barclay Millar in 1891 (NSW); Queensland, Cook Dist., near Almaden, Four Mile Creek Almaden on side of Burke Developmental Road, alt. ca. 500 m. 24 July 1998. Ohashi, Nemoto, Endo & Pedley 62003 (CBM, TUS); Mungana, railway terminus, 149 miles W of Cairns. Thurston 614 (NSW); Alma Den. White 1351, Feb. 1922 (A, NSW).

Fiji. U.S. South Pacific Exploring Expedition 1832–42 (GH); Yasawa Is., Waya I, coast W. of Yalobi village, alt. ca. 5 m. Gardner 6455 (TUS).

Distribution: New Guinea, N. Australia (N. Queensland), New Hebridis, New Caledonia.

3. **Dendrolobium umbellatum** (L.) Benth. in Miq., Pl. Jungh.: 216 & 218 (1852); Schindl. in Repert. Spec. Nov. Regni Veg. **20**: 278 (1924); Ohashi in Ginkgoana **1**: 82 (1973); Huang & Ohashi in Fl. Taiwan **3**: 250, t. 570 (1977); Smith, Fl. Vit. Nov. **3**: 186 (1985); Polhill in Fl. Mascar. 80 Légum: 96, t. 33

(1990); Huang & Ohashi in Fl. Taiwan ed. 2, **3**: 244, t. 116 (1993); Lock & Heald, Legum. Indo-China: 68 (1994); Dy Phon in Fl. Camb. Laos Viet. **27**: 26 (1994); Ohashi in J. Jpn. Bot. **70**: 113 (1995); Yang & Huang in Fl. Reip. Pop. Sin. **41**: 7 (1995); Pedley in Rev. Fl. Ceylon **10**: 162 (1996); Ohashi in Taiwania **42**: 139 (1997).

Hedysarum umbellatum L., Sp. Pl.: 747 (1753). [Type: Ceylon, Herb. Linne 921.28 (LINN)].

Hedysarum australe Willd., Sp. Pl. **3**(2): 1183 (1802).

Desmodium australe (Willd.) DC., Prodr. **2**: 326 (1825).

Desmodium umbellatum (L.) DC., Prodr. **2**: 325 (1825); Benth., Fl. Austr. **2**: 230 (1864); van Meeuwen in Reinwardtia **6**: 263 (1962); Verdcourt, Man. New Guinea Leg.: 410 (1979); Sanjappa, Legum. Ind.: 165 (1992).

Dendrolobium australe (Willd.) Benth. in Miq., Pl. Jungh.: 216 (1852).

Distribution: Africa, Asia, Australia, and Pacific islands. In Asia: Sri Lanka, South India, Burma (=Myanmar), Indo-China (Thailand, Cambodia, Vietnam), Malaysia, South

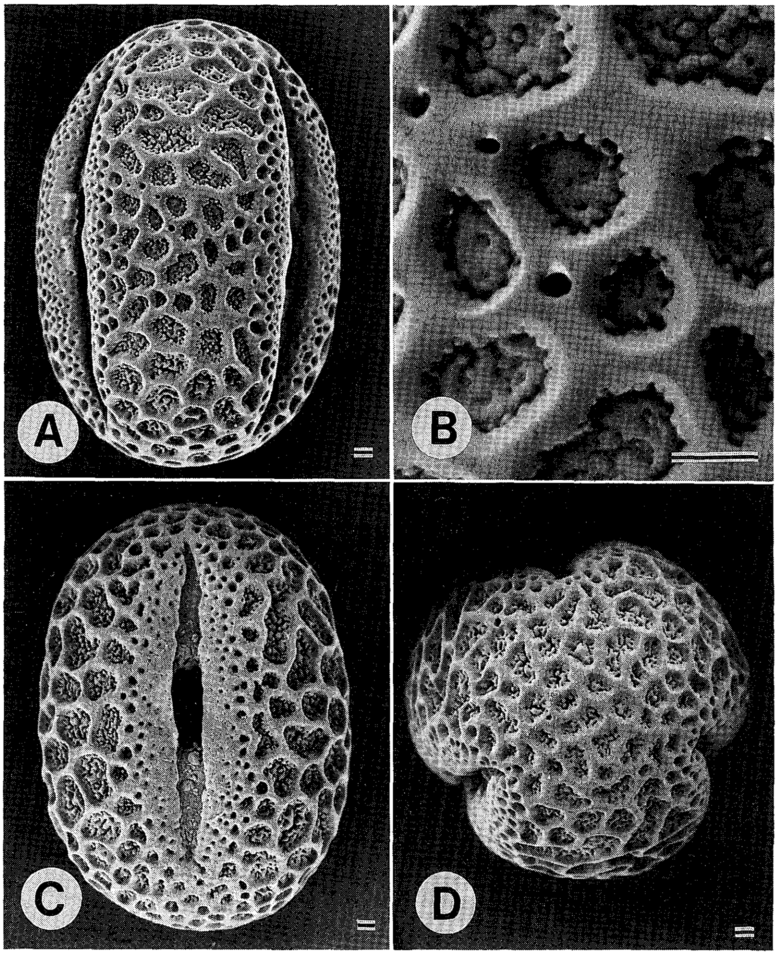

Fig. 7. Pollen grains of *Dendrolobium umbellatum*. A. Equatorial view showing mesocolpium. B. Mesocolpium, enlarged. C. Equatorial view showing a colpus, D. Polar view. Scale bar = 1 μm. Voucher specimen: Taiwan, C.E. Chang 11817 (TUS).

China, South Taiwan, and Ryukyu (Okinawa).

Pollen morphology of *Dendrolobium umbellatum* (L.) Benth.

Pollen grains (Fig. 7) tricolporate; (21–) 23 (–26) μm in polar axis, (14–)16(–19) μm in equatorial diameter; P/E = (1.18–)1.28(–1.35), subprolate to prolate in shape, elliptic or rectangular-elliptic in equatorial view, semi-angular in polar view; colpi long, 0.7–0.8 the length of the polar axis, very narrow, ca. 1.5 μm wide at equator, narrowing to pointed ends, colpus membrane with fine granules, margins with a complete tectum; endoaperture 0.2–0.3 the length of polar axis; semitectate; sculpture in mesocolpium reticulate, lumina 1.5–3.2 μm in diameter, with columellae elements.

Dendrolobium umbellatum (L.) Benth. is characteristic in having elliptic, ovate to broadly ovate, or obovate terminal leaflet which is usually longer than 5 cm, usually reduced racemes or umbels, wings smaller than the keel and the lowest calyx-lobe is not longer than other lobes.

Distribution: East Africa, Madagascar, South India, Indo-China, Malaysia, China, Taiwan, Ryukyus (Isl. Okinawa, the northern limit of distribution), the Pacific Islands, East Australia (North Queensland).

Specimens collected by TUS Expedition team in Australia: Queensland. North Kennedy Dist.: Bingil Bay, seaside. 26 July 1998. Ohashi, Nemoto, Endo & Pedley 62001 (CBM, TUS); North Kennedy Dist.: Mission Beach, seaside. 26 July 1998. Ohashi, Nemoto, Endo & Pedley 62002 (CBM, TUS).

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大橋広好・葉　續・根本智行：マメ科*Dendrolobium arbuscula* (Domin) H.Ohashi, *D. umbellatum* (L.) Benth.および近縁の1新種

Desmodium arbuscula Dominはオーストラリアのクインズランド北部から記載されたが（Domin 1926），最近になってニューギニア，フィジーおよびオーストラリアのクインズランド北部に分布するナハキハギ属の1種であることが明らかにされ，学名を*Dendrolobium arbuscula* (Domin) H.Ohashiと変更された（Ohashi 1997）．この種はナハキハギ*Dendrolobium umbellatum* (L.) Benth.に近縁であるとされていたが，両種の区分は十分には再検討されないままであった．本論文では，両種の形態上の区別点を明らかにし，花粉形態を比較した．さらに，この研究の過程で，パプア・ニューギニアから両種に近縁の新種を発見したので，これを*Dendrolobium papuacola* H. Ohashi & T. Nemotoと命名し記載した．　　（東北大学大学院理学研究科）